MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY

VOL. 56, No. 2
W. B. No. 945

FEBRUARY, 1928

CLOSED APRIL 3, 1928
ISSUED APRIL 30, 1928

THE CLIMATE OF SOUTHEASTERN PENNSYLVANIA [1]

By PROF. HENRY F. JAMES

[University of Pennsylvania, Philadelphia, Pa.]

The greatest influence that nature exerts over man's temporal well-being is through climate. Man is a puppet, due to practically uncontrollable atmospheric forces. Helpless and almost powerless, he watches with fear and misgivings or with joy and ecstasy the march of the seasons with their ever changing parade of storms, sunshine, rain, wind, sleet, hail, and snow. His religion, in fact almost his very life, is molded and fashioned by temperature, moisture, sunshine, wind, and storm. He is a gambler by necessity because of atmospheric conditions that are all pervading and all powerful.

Climatic influences being important in the economic development of all lands and peoples, an analysis of the climate of southeastern Pennsylvania is essential to a clear understanding of its conditions, possibilities, and prospects. Southeastern Pennsylvania in this paper includes all land lying between South Mountain and Philadelphia in the province called by the physiographers, the Pennsylvania Piedmont. (See frontispiece.)

Temperature.—In temperature, one of the main meteorological factors, this region occupies a favorable position on the climatic chart, for its average annual temperatures approach closely the average for the entire world (59° F.). Due to its intermediate position, its temperatures are at times equable when the oceanic influence is in the ascendancy and decidedly variable when dominated by continental conditions. Its temperatures can also be said to partake slightly of the nature of both at times. The oceanic influence is less noticeable than on the Pacific coast of the United States in the same latitude because of its position on the windward side of the Atlantic Ocean. The reverse is true of the continental influence.

The region also extends into the zone of activity of the barometric depressions or storms that are frequent western visitors to northeastern United States by way of the Great Lakes and the St. Lawrence Valley. The visits of these cyclones and anticyclones are most numerous during the cold months with the result that every type of weather almost may be experienced during the winter period. February, 1899, saw minimum temperatures as follows: February 9, 1° F. below zero; 10th, 6° F. below; and the 11th, 6° F. below. This, however, was the only time in 40 years when the temperature reached or passed below the zero mark on two or more successive dates. Cold waves, however, are decidedly modified when they reach the Atlantic coast. The records of the Weather Bureau state that on the average only 3 out of every 12 cold waves that enter the United States in the extreme Northwest retain sufficient severity to be so classified on reaching southeastern Pennsylvania. In contrast with February, 1899, we have January, 1790, with a mean temperature of 12° F. above the normal. Of this month Charles Peirce says,[2] "The midday temperatures were frequently 70° in the shade, and boys were seen swimming in the Delaware."

Relative inactive atmospheric elements prevail during the summer months due to the less frequent and less intense development of the cyclones and anticyclones. The temperature conditions of land and water during this period are more uniform, a condition that produces a sluggish and inactive atmosphere. The general absence of clouds allow for the excessive heating of the earth and adjacent atmosphere at times. Such conditions are indicated in the records of the Philadelphia Weather Bureau, which show that from June 25 to July 6, 1901, there was a period of intense heat. The maximum temperature was 90° F. or above on 12 successive days. On July 2, the maximum temperature reached 103° F. June, 1925, also produced an intense heat period. During this time 7 successive days with a maximum temperature above 90° F. occurred. One hundred years earlier, the Democratic Press of Philadelphia under the heading, "Warm Weather," reported that on Thursday, June 9, 1825, a thermometer on the south side of Chestnut Street, between Second and Third Streets, fronting the north was as high as 96° F. The same thermometer at the same hour and exposure reached 97° F. on Friday and 96° F. on Saturday. These hot periods are usually broken by cyclonic and anticyclonic movements for a week or so that finally culminate in a period of very general thunderstorms and a shift of the wind to a northerly quarter. Any pressure formation that will bring about a shift of the wind to a northerly quarter, such, for example, as the northward movement off the coast of a West Indian hurricane is also effective in producing a lowering of the summer temperature. Cases of this sort are, however, rather infrequent. The thunderstorms are storms of only short duration, but are at times of great intensity.

The summer temperatures are not always hot in this region. The year 1816 is known as "The year without a summer." From the diary of Charles Peirce,[2] we notice the following statements. "May—Ice froze from a quarter to a half inch in thickness. Corn was planted two or three times and froze out. A melancholy hue seemed to seal the fate of all vegetable life. June—the coldest

[1] All statistics, unless otherwise indicated, obtained from the U. S. Weather Bureau records at Philadelphia.

[2] Peirce, Charles, Meteorological Account of the Weather in Philadelphia from Jan. 1, 1790 to Jan. 1, 1847.

RELIEF MAP OF PENNSYLVANIA

SCALE OF MILES

0 5 10 20 30 40 50 60 70 80 90 100

I - COASTAL PLAIN
II - PIEDMONT PLATEAU
III - APPALACHIAN HIGHLANDS
IV - APPALACHIAN PLATEAU

(To face p. 35)

June on record. Killing frosts occurred on several mornings and nearly all vegetables were killed. July—a month of heavy frosts and ice. On the morning of the 5th ice formed as thick as window glass. August—ice formed a half inch in thickness and everything green was destroyed."[3]

The temperature of this region is not ordinarily subject to the extremes that visit the interior United States. Temperatures of 110° F. have been recorded in the Dakotas. In Montana the midwinter temperatures often reach 25° or 30° F. below zero. The temperature, too, is moderate as compared with other parts of the State. Lawrenceville in central Pennsylvania reports a minimum temperature of 39° F. below zero. Claysville, western Pennsylvania, has experienced a maximum temperature of 108° F. Temperatures of 100° F. or higher are rarely recorded in this region, but the high humidity, sometimes makes the temperature conditions oppressive. During the hottest periods of summer the wind movement is generally light and affords but little relief. These periods, however, are generally broken up within a week or 10 days by fresh northeast winds. The winters are mild, there being an average of less than 100 days with a minimum temperature below the freezing point while zero temperatures are seldom reached more than once or twice during the winter season. Between 1874 and 1924 inclusive only 23 days with a temperature below zero were recorded in Philadelphia. Temperature conditions over an extended period are indicated in Tables 1 and 2.

TABLE 1.—*Average number of days with temperature 90° F. or above*

	January	February	March	April	May	June	July	August	September	October	November	December	Total	Years of record
Gettysburg	0	0	0	0	2	5	10	6	2	0	0	0	25	20
Reading	0	0	0	0	1	4	8	4	2	0	0	0	19	21
Philadelphia	0	0	0	0	0	3	6	3	1	0	0	0	13	37
State College	0	0	0	0	0	1	2	2	1	0	0	0	6	25
Pittsburgh	0	0	0	0	1	3	7	4	2	0	0	0	17	46
Erie	0	0	0	0	0	0	1	1	0	0	0	0	2	48

TABLE 2.—*Average number of days with temperature 32° F. or below*

	January	February	March	April	May	June	July	August	September	October	November	December	Total	Years of record
Gettysburg	27	25	20	7	0	0	0	0	0	4	16	26	125	20
State College	28	22	22	9	1	0	0	0	0	4	16	27	129	25
Erie	27	25	23	8	0	0	0	0	0	1	11	23	118	48
Pittsburgh	24	22	15	5	0	0	0	0	0	1	10	21	98	46
Philadelphia	22	20	13	2	0	0	0	0	0	0	6	18	81	40
Reading	26	25	18	5	0	0	0	0	0	2	12	25	113	21
West Chester	25	24	16	5	0	0	0	0	0	1	11	24	106	20

Neither areal extent nor relief is sufficiently great to produce outstanding contrasts within the area. Slight variations are caused by (1) differences in elevation; (2) location in relation to the ocean and latitude; and (3) slight differences in the exposure of the instruments.

[3] Against this pessimistic view see the following excerpt from the Boston Recorder of Aug. 7, 1816: In relation to the season, accounts from all parts of the country present an agreeable reversal of the gloomy reports which were made a few weeks ago. Fruits of every description will be abundant. All kinds of grain except corn are more promising than in ordinary seasons.

Tables Nos. 1, 2, 3, and 4 indicate the outstanding differences of temperature between representative places within the area and selected stations elsewhere in Pennsylvania.

TABLE 3.—*Temperature, elevation, and distance from nearest water body*

Station	Average mean winter, Dec.–Feb.	Average mean summer, June–Aug.	Average mean spring, Mar.–May	Average mean fall, Sept.–Nov.	Annual mean temperature	Mean maximum annual	Mean minimum annual	Elevation above mean sea level	Distance, Miles
Philadelphia (Coastal Plain).	33.86 Jan.	74.1 July	51.6 Mar.	56.9 Sept.	54.1	62.1 July	46.4 Jan.	157	50
	32.7	76.5	40.6	68.1		84.5	26		
Coatesville (Chester Valley).	31.1 Feb.	71.4 July	50.6 Mar.	54.4 Sept.	51.9	63.4 July	42 Feb.	380	85
	29.9	74.7	39.4	66.1		86.4	20.2		
West Chester-Trenton).	31.3 Jan.	71.9 July	49.6 Mar.	54.2 Sept.	51.8	61.3 July	43.6 Feb.	450	75
	30.2	74.3	38.3	65.3		84.7	21.4		
Lancaster (Limestone Plain).	30.9 Jan.	72.1 July	49.9 Mar.	53.6 Sept.	51.6	63.8 July	40.0 Feb.	255	110
	29.6	73.4	38.0	64.5		86.4	19.4		
York (Limestone Valley).	30.5 Jan.	72.3 July	50.6 Mar.	53.9 Sept.	51.8	63.0 July	41.3 Jan.	400	125
	29.3	74.4	39.4	65.6		86.6	20.4		
Quakertown (Triassic Lowlands).	28.8 Jan.	69.3 July	48.1 Mar.	52.3 Sept.	49.6	61.5 July	39.9 Feb.	496	65
	27	72.5	36.3	63.6		86.0	18.5		
Gettysburg (Triassic Lowlands).	30.3 Jan.	71.8 July	50.3 Mar.	52.8 Sept.	51.3	63.1 July	41.4 Feb.	600	135
	29	74.0	39.2	65.0		86.9	19.7		
Erie	28.2 Feb.	68.9 July	45.0 Mar.	52.6 Sept.	48.7	55.9 July	41.6 Feb.	714	0
	25.8	71.2	33.6	63.2		78.3	18.4		

Frost.—Of all portions of Pennsylvania this region is the most highly favored as regards the length of the frost-free season. Philadelphia, with a minimum growing season of 157 days and an average season of 207 days, is the most favored. The South Mountain farming districts are handicapped by a much shorter period free from frost. In the most important farming sections frosts are infrequent between May 1 and October 1. The latest date (Government records) for frost was May 29 (Quakertown station). Farmers in most parts of the area can depend on an average growing season of approximately 180 days, varying from 160 days at Quakertown to 207 days in the vicinity of Philadelphia. (See Table 4.)

TABLE 4.—*Frost dates*

	Average date of last killing	Latest date	Average date of first killing	Earliest date	Average growing season	Minimum growing season	Elevation, feet	Years of record
Gettysburg	Apr. 21	May 14	Oct. 19	Sept. 22	181	131	600	18
Lancaster	Apr. 27	May 27	Oct. 6	Sept. 11	162	107	255	13
State College	Apr. 29	May 29	---do---	---do---	160	105	1,217	36
York	Apr. 23	May 17	Oct. 8	---do---	168	149	400	16
Erie	Apr. 20	---do---	Oct. 2	Sept. 9	196	145	714	37
Pittsburgh	Apr. 21	May 29	Oct. 22	Sept. 25	184	119	842	48
Coatesville	Apr. 20	May 12	Oct. 17	Sept. 22	180	133	380	27
Philadelphia	Apr. 7	May 29	Oct. 31	Sept. 3	207	157	156	48
Quakertown	Apr. 30	---do---	Oct. 7	Sept. 15	160	109	496	24
Reading	Apr. 15	May 5	Oct. 15	Sept. 1	183	149	325	25
Kennett Square	Apr. 19	May 17	Oct. 22	Sept. 2	186	138	275	25

Light frosts.—A light frost, injurious only to tender plants may and frequently does occur with a recorded minimum temperature of 39° F. to 40° F. Hence the period of safe growth for the more delicate varieties of vegetation is much less than for the ordinary frost-free period. A minimum of 39° has been recorded at Philadelphia as late as May 11 (1913). The spring minimum of 39° has occurred as early as March 27 (1912) in the period between 1911 and 1925. (Table 5.)

TABLE 5.—*Light frost periods, 1911 to 1924, at Philadelphia*

Year	Latest spring date	° F.	Earliest autumn date	° F.	Days
1911	Apr. 23	37	Nov. 2	34	193
	May 3	40			183
1912	Apr. 9	36	do	39	207
	Apr. 30	40			
1913	May 11	39	Oct. 22	40	164
			Nov. 1	37	174
1914	Apr. 14	37	Oct. 25	35	194
1915	Apr. 4	30	Nov. 5	39	215
1916	Apr. 11	39	Oct. 1	40	173
			Oct. 14	37	186
1917	Apr. 25	40	Oct. 13	36	171
	Apr. 15	37			181
1918	Apr. 25	40	Nov. 7	38	196
	Apr. 13	35			208
1919	Apr. 26	35	Nov. 2	40	190
			Nov. 3	38	191
1920	Apr. 14	38	Nov. 12	29	212
	Apr. 27	42			199
1921	Apr. 19	37	Oct. 9	41	173
			Oct. 26	36	190
1922	Apr. 24	37	Oct. 19	39	178
1923	May 10	38	Nov. 1	36	175
1924	Apr. 21	40			
1925	do	34	Oct. 21	39	183

Average period free from light frost, 188 days.

Temperature changes.—Temperature conditions over a long period of time are not noticeably changing in this region. The annual mean temperatures possess remarkable uniformity. The 47 years of Pennsylvania Hospital records indicate a 53.7° mean. Weather Bureau records for 40 years following record a 54° mean. Harsh and mild winter weather prevails. Summers may be intensely hot or cool but the total amount of heat received in southeastern Pennsylvania over an extended period has not changed.

Precipitation in southeastern Pennsylvania.—After temperature, the next most important climatic factor is the moisture, either as water vapor or as water in the form of rain, snow, and the like. The rainfall determines the productiveness of a country if the temperature and sunshine are sufficient for plant life. The beneficial effects of rainfall depend upon quantity and often to an equal extent upon the time and frequency of occurrence and the rate of precipitation. As a rule, a given amount falling rapidly is of less value, agriculturally, than an equal or less amount falling more slowly.

This region has a great advantage as to rainfall, the average precipitation of 46 inches being almost ideal for agriculture. One has to be aware that only 25 per cent of the land surface of the globe receives over 40 inches annually to realize to what degree this region is favored.

Considerable variation in the mean annual rainfall of different stations is noticed. Lancaster reports 40.39 inches, Doylestown 49.22 inches, and Philadelphia 41.43 inches. The variation is probably due to position and altitude. Slight variation may be accounted for on the basis of exposure of instruments and the degree of efficiency of the recorder. (See Table 6.) The smallest amount of precipitation (28.63 inches for any one year) was recorded at Gettysburg in 1856 and the maximum amount (73 inches) fell at West Chester in 1889.

The rainfall is usually well distributed throughout the year. (Table 6.) Coatesville reports that July has the highest average, with the heaviest rainfall, 12.93 inches, also falling in that month. August in Doylestown and Philadelphia is usually the month of greatest rainfall. Most rain falls in July in West Chester, Lancaster, and York. Summer appears to be the rainy period, with the dry period coming during the fall months. Heavy rainfall sometimes occurs in May. May, 1894, was an exceedingly wet month throughout the region, Coatesville reporting 11.72 inches. May, 1903, however, was dry. Doylestown reporting a rainfall of only 0.56 inch and Philadelphia 0.93 inch.

TABLE 6.—*Precipitation: Monthly, annual, and average amounts*

Station	January	February	March	April	May	June	July	August	September	October	November	December	Annual	Record in years
Chester Valley:														
Coatesville	3.97	4.10	4.36	3.63	4.03	4.04	5.02	4.43	3.90	3.52	3.19	4.22	48.41	
Heaviest	7.25	10.22	7.66	7.52	11.72	7.18	12.93	9.84	9.12	6.78	8.60	9.24	68.94	30
Lightest	1.36	1.03	0.49	1.38	1.19	1.46	1.16	0.46	0.71	0.48	1.01	0.59	32.70	
Snowfall	9.8	12.7	9.3	2.5	0	0	0	0	0	Trace.	2.3	7.9	44.5	
Triassic lowlands:														
Doylestown	3.66	3.86	4.07	3.98	4.01	4.00	4.86	5.53	3.95	3.98	3.30	4.02	49.22	
Heaviest	6.78	5.51	9.71	7.93	1.41	10.29	11.87	14.00	9.69	8.68	10.05	7.96	67.08	20
Lightest	1.03	1.17	0.89	1.65	0.56	1.18	0.16	1.32	0.34	0.17	0.53	1.07	31.87	
Coastal plain:														
Philadelphia	3.27	3.31	3.48	3.16	3.33	3.31	4.24	4.74	3.33	2.94	2.99	3.33	41.43	
Heaviest	6.74	6.87	9.10	9.76	9.46	8.04	10.30	12.10	12.09	66.6	7.31	7.35	55.28	48
Lightest	1.49	0.84	0.38	0.61	0.54	0.74	0.75	0.46	0.20	0.30	0.67	0.83	30.21	
Snowfall	6.7	7.5	4.5	1.2	0	0	0	0	0	0	0.8	4.8	25.5	
Trenton prong:														
West Chester	3.83	3.90	4.07	3.78	4.45	4.19	4.83	4.68	3.92	3.74	3.63	4.09	49.12	
Heaviest	7.32	7.29	8.33	8.80	13.82	9.32	14.58	12.35	12.33	8.66	9.91	8.59	73.00	71
Lightest	0.81	0.47	0.52	1.10	0.83	0.96	0.73	0.55	0 29	0.36	0.74	0.59	33.03	
Snowfall	9.7	9.1	6.8	1.5	0	0	0	0	0	0	1.7	6.9	34.7	
Limestone plain:														
Lancaster	3.25	2.68	3.45	3.54	3.28	3.99	3.92	4.08	3.34	3.08	2.42	3.41	40.39	
Heaviest	4.79	5.66	6.61	6.54	7.04	7.98	9.17	9.62	8.43	7.34	9.02	6.08	52.25	13
Lightest	1.57	0.59	0.50	1.20	0.74	1.08	1.18	1.13	0.28	0.28	0.72	0.60	28.63	
Snowfall	8.2	7.6	9.5	2.8	0	0	0	0	0	0	0.6	9.7	42.8	
Triassic lowlands:														
Gettysburg	3.14	2.81	3.16	3.60	3.97	3.90	3.62	4.07	3.37	3.20	2.67	3.33	40.84	
Heaviest	7.22	7.11	8.00	6.09	10.95	8.58	9.08	12.99	8.71	7.57	8.48	6.08	52.25	20
Lightest	0.63	0.98	0.48	0.62	1.10	0.26	0.85	0.45	0.72	0.55	0.38	0.60	28.63	
Snowfall	12.0	9.8	7.8	1.9	0	0	0	0	0	0	1.6	9.7	42.8	

Between the years 1900 and 1919, inclusive, Lancaster, Philadelphia, and West Chester report the following critical monthly rainfall conditions. (See Table 7.)

TABLE 7.—*Number of days with monthly rainfall as indicated, 1900–1919, 20 years*

[(1) Lancaster, (2) West Chester, (3) Philadelphia]

Critical months	1 inch or less	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 8	8 to 10	Over 10
March (1)	2	3	3	5	5	2	0	0	0
(2)	1	1	2	4	7	4	0	1	0
(3)	2	0	6	5	4	2	0	1	0
April (1)	0	2	5	9	2	2	0	0	0
(2)	0	0	6	7	4	1	1	1	0
(3)	0	2	6	6	5	0	1	0	0
May (1)	2	2	7	5	3	1	0	0	0
(2)	0	3	2	4	6	4	1	0	0
(3)	2	2	6	0	6	2	2	0	0
June (1)	0	2	5	3	3	4	3	0	0
(2)	0	1	3	5	4	1	6	0	0
(3)	0	3	9	2	1	3	1	1	0
July (1)	0	2	2	5	4	2	4	1	0
(2)	1	0	4	4	3	3	3	0	2
(3)	0	1	3	6	5	3	1	0	1
August (1)	0	3	4	7	1	0	3	2	0
(2)	0	3	3	0	2	4	5	2	1
(3)	1	2	2	4	2	3	2	3	1

The normal rainfall is ample for the growing of the staples of the area. The annual rainfall if well distributed would be sufficient even in the driest year, but occasionally there exists a marked seasonal deficiency or excess, either of which may be detrimental, particularly the former. During some seasons of the year this scarcity of rain is comparatively unimportant, but during periods of critical crop growth it becomes a question of serious moment.

Dry spells.—Dry spells are most frequent after the harvest season in the autumn months of September, October, and November. In consecutive periods of seven days or over the Weather Bureau records at Philadelphia between the years 1872 and 1924, inclusive, show the total number of days with a rainfall of less than 0.01 of an inch to be divided among the months as indicated in Table 8. The autumn dry spell of 1914 was especially noticeable—less than 0.01 of an inch of rainfall from September 3 to September 23, a period of 21 days.

TABLE 8.—*Number of consecutive days in periods of a week or more with less than 0.01 inch of rain*

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
39	96	89	181	220	135	109	173	299	274	182	101	1,898

After a short break dry weather began on the 26th and lasted until October 14, making a total period of 40 days with practically the minimum of rain. In this period of drought the rivers were very low and the ground exceedingly dry. In 1910 only 0.01 inch of rain fell between September 7 and October 6, a period of 30 days. Rainfall in May at Lancaster has been below normal 14 times in the last 21 years. Only twice, however, has less than one inch fallen at Lancaster during May in a 21-year period. During those years (1902–1923) there were 36 consecutive days in the May months with a rainfall of 0.01 inch or less at Philadelphia. Although the May month of these two years was dry, its effect was somewhat modified by heavy winter rains and normal March and April precipitation. In each case also the summer period was extremely rainy. Rainfall during the summer of 1902 was 3.34 inches above normal, and 5.89 inches excessive rainfall fell in 1903 at Lancaster. Droughts as they occur in more westerly States are unknown and where the land is in really good tilth, crops usually weather even the driest spells. Land not in good tilth and land of uncertain types on exposed slopes suffer during the dry period. Dry spells that do a great deal of damage occur on an average of only two or three times in a decade. Total crop failures are even then usually prevented by timely showers.

Wet spells.—Rain or snow storms do not usually exceed two or three days in duration. There are frequently periods, however, of much more extended rainy or cloudy weather.

On August 3, 1898, there was in Philadelphia a rainfall of 5.48 inches in two hours and 5.89 inches in the 24-hour period. The lightning was terrific and many buildings were struck.

A large number of sewers burst and many cellars were flooded. Between May 21, 1897, and September 6, 1910, the Philadelphia office has recorded 66 storms with excessive precipitation.[4] Excessive rains in summer are usually accompanied by thunderstorms. These occur most frequently in the month of July. June and August are close rivals. Between 1885 and 1910, July has averaged seven thunderstorms (not all, however, carrying excessive precipitation). In the year 1905, 51 thunderstorms were recorded. Thirteen thunderstorms in July (1901) and the same number in July, 1902, were the greatest number recorded in any one month.

An interesting comparison of the frequency of days with thunderstorms in 12 representative cities of the United States is made in Table 9. Only three cities, Boston, Mass., New York, N. Y., and Los Angeles, Calif., had fewer days with thunderstorms annually than Philadelphia between the years 1904 and 1923.

TABLE 9.—*Frequency of days with thunderstorms in 12 representative American cities, 1904–1923* [1]

City	Number of days with thunderstorms (yearly average)	City	Number of days with thunderstorms (yearly average)
Baltimore	34	Los Angeles	4
Boston	19	New Orleans	74
Chicago	41	New York	31
Cincinnati	50	Philadelphia	33
Cleveland	38	Pittsburgh	46
Detroit	38	St. Louis	50

[1] Alexander, W. H.: Distribution of thunderstorms in the United States. MONTHLY WEATHER REVIEW, 52, 337-343.

Although the thunderstorms in July are most numerous, the August storms produce greater rainfall per storm. In 50 years (1874–1924) there were 10 storms in July with a precipitation of 1 inch or over an hour. The average was 1.285. In the same period August recorded 25 such storms with an average precipitation of 1.5796. The greatest precipitation in one hour also occurred in August when 5.43 inches of rain fell on August 3, 1898. This probably indicates a greater severity of the August thunderstorms. June in the same period produced only seven such thunderstorms with the greatest precipitation being 1.90 inches, September recorded 11 with a maxi-

[4] Precipitation is excessive if greater than 1 inch in two hours or 0.50 inch in 30 minutes.

mum precipitation of 2.43 inches per hour. Eight storms were divided as follows:

Month	Number	Maximum amount of precipitation per hour
February	2	1.11
April	1	1.68
May	4	1.38
October	1	1.53

Summer rains are less than half the duration of those of the winter. February is the winter month with excessive precipitation occurring within an hour. February 28, 1902, witnessed a storm in which 0.97 inch fell in half an hour and a total of 1.36 inches fell between 7:40 a. m. and 4:15 p. m. February rains are of the cyclonic type as compared with the convectional rains of the summer months. Floods are most common in February and March when the ground is frozen or has been saturated by previous rains. Flood damage is not extensive, however, except along the meadowlands and low river terraces. On October 23, 1878, during a heavy windstorm, the truck farms and bottom lands were flooded by backwater from the Delaware River and Bay, the water attaining the highest point in more than 80 years. Ice freshets during the winter and spring months and heavy rains in the summer will, at times, increase the Schuylkill River at Manayunk above ordinary low-water mark as much as 27 feet (1869) and 21 feet (1894). Floods of this height will cause property damage in river towns, destruction of bridges, and flooding of river bottoms. No floods, such as are experienced along the Ohio and Mississippi Rivers, occur in southeastern Pennsylvania.

Narrow river valleys with little level land and limited drainage basins adjoining make floods harmless when compared with the great floods of the Middle West.

Snowfall.—Precipitation is largely in the form of rain. The mean annual snowfall for nine scattered stations throughout the region is 35.4 inches. This is a comparatively light snowfall. Coatesville reports the largest annual snowfall and Philadelphia the least. During a 30-year period, 44.5 inches of snow has fallen annually in Coatesville and 25.5 inches at Philadelphia. Grampian (central Pennsylvania) reports 72.7 inches average per year, and Montrose (western Pennsylvania) reports 71.6 inches. A large part of the winter precipitation is rain or rain and snow mixed. Occasional heavy snows occur as on March 12, 1888, when 10 inches of snow fell and in the night of December 25, 1909, when there was a snowfall of 21 inches in Philadelphia. The greatest depth of snow on the ground in Philadelphia was 26 inches in 1899. In contrast, the year 1901 had only 3 inches on the ground at any one time. The total snowfall of that year was only 11.4 inches. The least snowfall was during the year 1889 when a total of 5.7 inches fell in Philadelphia, and the greatest in 1907 (44.6 inches). Most of the snow falls during the months of January and February. These months are closely followed in amount by March and December. Only infrequently does the snow remain for an extended period as a blanket covering the ground.

Frequently the daily temperatures rise above freezing, even in midwinter, and the winter rains soon transform the snow into slush.

Hail and wind storms.—Hailstorms and severe windstorms of tornadic nature are not common in this region and where they do appear are greatly restricted in extent. They have been known, however, to do very serious local damage. The Evening Public Ledger of Tuesday, June 16, 1925, reported that two deaths and damage of more than $20,000 resulted from a sharp electrical storm that broke over the city of Chester early that same day. It also states that in the western part of the city the roofs of a dozen houses were blown off, the window of a department store broken by the wind, and scores of persons hurt by hailstones. The wind was estimated to have had a velocity of 60 miles an hour. Between the years 1911 and 1916, inclusive, the Philadelphia Weather Bureau reported six days with hail, one each in February, May, June, July, August, and November.

The records for the years 1911 to 1924, inclusive, show an average of 78 days per year with a wind velocity of 25 miles or over, but only a 3½-day yearly average with wind velocity over 40 miles. January heads the list, followed by March and August. The heavy winds are mostly of the winter and spring varieties and are the result of the greater development of the pressure areas during the winter months. The August winds are more the result of unequal local heating and usually accompany thunderstorms. A velocity of 75 miles per hour was experienced only once in 39 years, and a velocity of 60 miles an hour or over was recorded five times. Velocities of over 40 miles per hour in the same period occurred on 114 different occasions.[5]

HUMIDITY AND FOGS

Humidity, the invisible moisture of the atmosphere, has important functions to perform. It tempers the heat and cold. Extremes of temperatures do not prevail where humidity is present in large amounts. It is the great source of supply of precipitation. It is also at times a source of personal discomfort. High relative humidity with a high temperature causes the air to feel muggy and man to lose energy through the prevention of rapid evaporation. High humidity plus a low temperature produces a raw atmospheric condition. A moderate temperature becomes oppressively hot when the humidity approaches or exceeds 80 per cent. Temperatures of 15° or 10° above zero with an 80 per cent humidity, a condition fairly common in this region, causes much suffering. Temperatures, however, of 20° below zero with a humidity of 25 to 30 per cent are described as comfortable and exhilarating in the Northwest.

Humidity is rather high at frequent intervals in southeastern Pennsylvania. During May, 1925, the relative humidity at 8 a. m. reached 80 per cent on 10 days out of the 31. On the 24th at 8 p. m. the relative humidity was 97 per cent and on the 29th it stood at 92 per cent. The mean for the month was 73 per cent at 8 a. m. The normal monthly means are indicated as follows:

Month	8 a. m.	8 p. m.	Month	8 a. m.	8 p. m.	Month	8 a. m.	8 p. m.
January	76	70	May	71	65	September	78	70
February	74	68	June	72	66	October	75	67
March	73	65	July	72	66	November	75	67
April	68	60	August	75	68	December	74	67

Mean annual relative humidity conditions of approximately 70 per cent divided, as indicated above, makes for many raw winter days and hot, oppressive summer days during the year in this neighborhood. August,

[5] A gale is technically defined as a wind velocity of 40 miles or over per hour.

with a 75 per cent average at 8 a. m. and a 68 per cent average at 8 p. m., is our most disagreeable month, while on many a January day the damp cold penetrates through the warmest of garments even with the temperature above zero.

Fogs of some nature are fairly common in this region during the months of November, December, and January. October, 1899, experienced eight days with fog, the greatest number of foggy days of any monthly period (1885–1910). The mean monthly (1871–1910) fog record is as follows:

January	1.30	May	0.1	September	0.8
February	.80	June	.2	October	.9
March	.70	July	.2	November	1.2
April	.30	August	.4	December	1.2

Dense fogs, however, are not of long duration, rarely continuing through any considerable portion of the day period. At times, however, they are a serious menace to shipping along the Delaware and to highway transportation throughout the entire region. Fogs do not interfere with plant growth for there is usually an abundance of sunshine during the growing season all through the region. The amount varies considerably in different months, but in all months the average is 59 per cent of the possible amount divided among the months as follows:

	Per cent		Per cent		Per cent
January	51	May	59	September	64
February	59	June	61	October	62
March	54	July	64	November	54
April	58	August	63	December	53

SUMMARY

The climate of this region may be considered as a modified marine type due to its proximity to the Atlantic Ocean. Throughout the largest and most important part of the region under discussion conditions approach the climatic mildness of the States of New Jersey, Delaware, and Maryland. Altitude and oceanic influences are responsible for this section of the State having milder temperature conditions than prevail elsewhere in Pennsylvania. The Erie plain on account of its close proximity to the lake has a mean temperature and a growing season of greater similarity to this region than to any other part of the State.

Southeastern Pennsylvania from a climatic point of view is the most favored part of the State for the development of a diversified agriculture. Its rainfall of over 45 inches, well distributed throughout the year, is well above the average for the State. The growing season is the longest, the winters are the mildest, and the danger of droughts less than any other part of Pennsylvania. The summer heat and humidity is excellent for the rapid development of plant life. Few storms of tornadic violence prevail and the crop damage is very small. Oppressive heat due to the high humidity makes many days disagreeable to man and beast in summer and the presence of many raw days in winter on account of the same high humidity modifies the mildness of the winter period. All things considered, however, the area possesses an exceptionally advantageous climate for the development of man, on the farm, in the factory, and at home.

LITERATURE CITED

ABBE, CLEVELAND.
A First Report on the Relationship between Climates and Crops. Bul. 36, U. S. Weather Bureau, 1905.

ALEXANDER, W. H.
Distribution of Thunderstorms in the United States. Monthly Weather Review, vol. 43, pp. 322–340, with tables, 1915.

BLISS, GEORGE S.
Climatology of Philadelphia. USDA. Weather Bureau Official Records of Philadelphia Weather Bureau. 1872–1925.

CLAYTON, H. H.
World Weather. Macmillan Co., 1923.

DAY, P. C.
Summary of Climatological Data for the United States, by sections:
Section 98, eastern Pennsylvania, establishment of the station to 1920, inclusive, pp. 1–14.
Section 96, western Pennsylvania, pp. 1–17.
Section 97, central Pennsylvania, pp. 1–19.
Frost Data of the United States. Weather Bureau Bulletin No. 5; Washington, 1911.

FASSIG, OLIVER LANARD.
Report on the Weather and Climate of Baltimore and Vicinity. Maryland Weather Service, Vol. II. Johns Hopkins Press, 1907.

GARRIOTT, E. B.
West Indian Hurricanes, Bulletin H. United States Weather Bureau, Washington, D. C., 1902.

GANNETT, HENRY.
Distribution of Rainfall in the United States. U. S. G. S., Water Supply Paper 234, 7–9, 1909.

HENRY, A. J.
Climatology of the United States. Weather Bureau Bulletin Q, 1906. Bulletin D, 1897—Rainfall of United States.

HUNTINGTON, ELLSWORTH.
Civilization and Climate.

KINCER, J. B.
Precipitation and Humidity. Atlas of Amer. Agriculture, Pt. II. Climate, Section A, U. S. D. A., 1922.

MERRILL, G. P.
Rocks, Rock Weathering, and Soils. Macmillan Co., New York, 1887.

PEIRCE, CHARLES.
Meteorological Account of the Weather of Philadelphia from January 1, 1790, to January 1, 1847. Lindsay and Blakeston, Philadelphia, 1847.

REED, W. G.
Frost and the Growing Season, Atlas of American Agriculture, Pt. II, Climate. Section A. U. S. D. A. 1920.

SMITH, J. W.
Agricultural Meteorology, the Effect of Weather on Crops. Macmillan Co., 1923.

WALZ, F. J.
Outline of the Present Knowledge of the Meteorology and Climatology of Maryland. Maryland Weather Service, Vol. I, pp. 417–551, Baltimore, 1899.